ACCESS II Flight Experiment Fuel Properties and Effects on Engine Performance

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ACCESS II Fuels

- Standard JP-8 fuel from NASA Armstrong Fuel Storage Tanks, 5/7/14
- HEFA - Camelina based Hydrotreated Esters and Fatty Acids from Honeywell UOP (same fuel used in ACCESS I), ~6200 gals
- Low Sulfur Jet A, Special Fuel(10 ppm or less) Produced by Chevron Phillips, FSII and Conductivity Added,~ 40,000 gals
- 50/50 Blend of HEFA-Low Sulfur Jet A
  - Blend 1, 4/29/14
  - Blend 2, 5/27/14
- Medium Sulfur Jet A – Produced by adding Tetrahydrothiophene (C_4H_8S) to the Low Sulfur Jet A, 5/12/14

Fuel Logistics

DANA Tanks used for Fuel Storage

10,000 gal fuel truck used to blend, mix, store, and supply HEFA/Jet A Blend

THT Sulfur Additive added to Low S Jet A in DANA Tank and pumped back and forth into a leased aviation fuel truck.

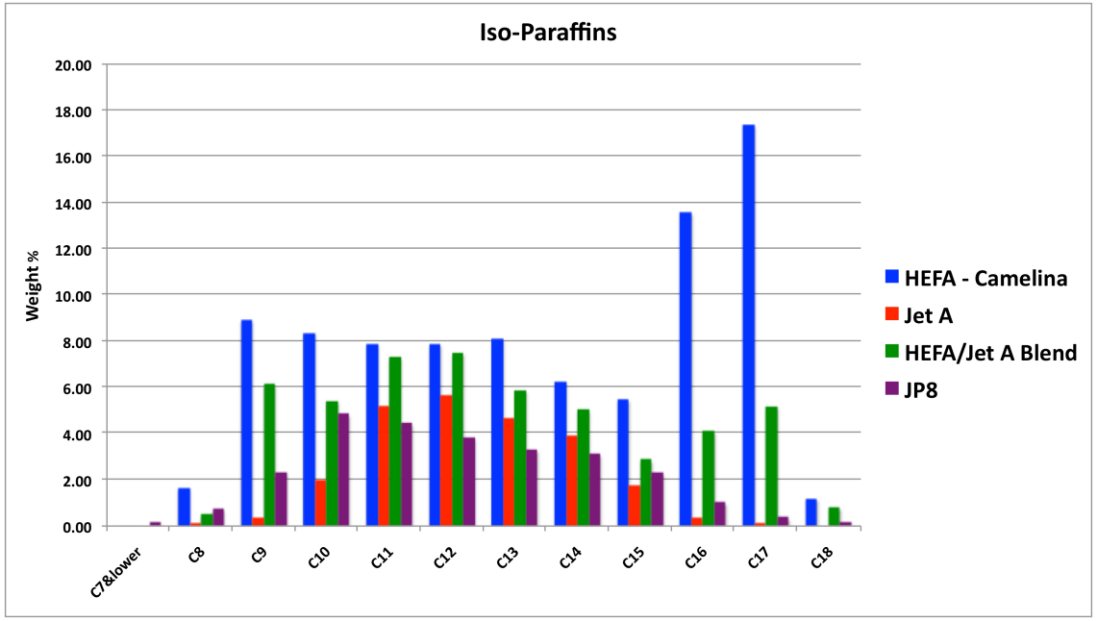
ACCESS II Fuel Properties

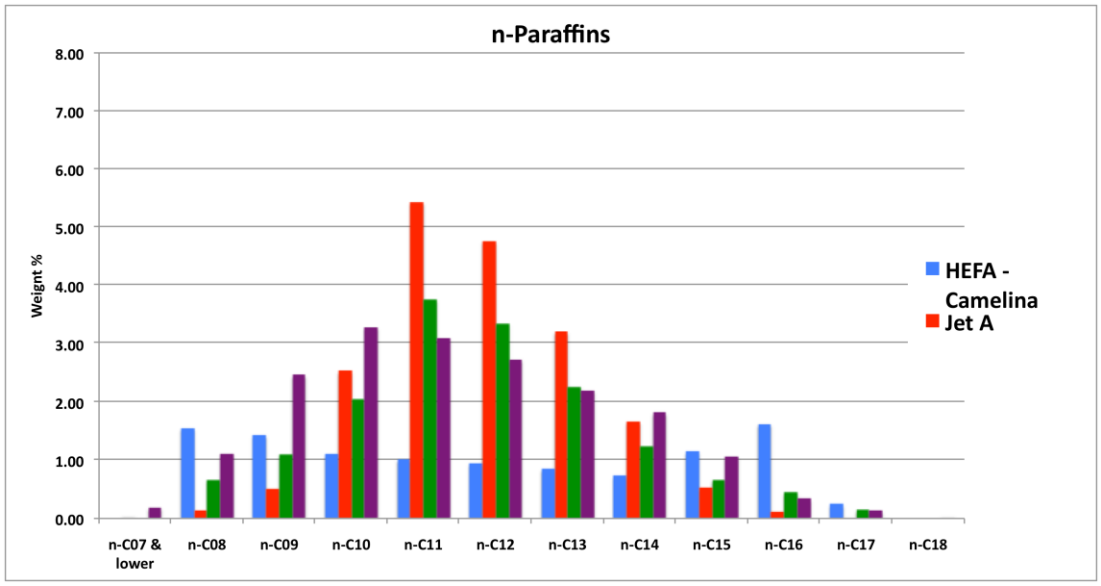
Fuel	JP8	HEFA	Low S Jet A	Low Sulfur Jet A	Medium Sulfur Jet A	HEFA/Low S Jet A Blend 1	HEFA/Low S Jet A Blend 2
Test	DC-8 Tank	As Delivered	As Delivered	DC-8 Tank	DC-8 Tank	Fuel Tanker	Fuel Tanker
Sulfur ppm (mass)	220	~ 0	9	20	426	16	8
Aromatics (% vol)	24.4	1	20.8	20.7	20.6	11.4	12
Density @ 15°C (kg/L)	0.809	0.758	0.81	0.809	0.81	0.785	0.786
Hydrogen Content (% mass)	13.7	-	13.7	13.9	13.8	14.8	14.9
Net Heat of Combustion (MJ/kg)	43.1	43.7	43.2	43.2	43.1	43.6	43.6
Flash Point (°C)	46	43	60	60	60	50	50
Freezing Point (°C)	-51	-60	-52	-54	-53	-58	-58
Viscosity @ -20°C (mm^2/s)	4.1	4.9	4.6	4.5	4.3	4.7	4.7
Smoke Point	21	42	25	22	22	30	30
Naphthalenes (% vol)	1	0	0.7	0.6	0.7	0.4	-
Olefins (% vol)	0.7	-	-	1.2	0.9	0.7	0.7
Distillation							
10% Recovered (°C)	169	156	191	190	190	174	175
20% Recovered (°C)	177	-	194	194	195	181	183
50% Recovered (°C)	203	206	206	206	206	208	208
90% Recovered (°C)	246	275	232	233	233	259	257
End Point (°C)	272	281	251	252	252	276	275
Residue (% vol)	1.2	1.3	1.2	1.2	1.2	1.2	1.2
Loss (% vol)	0.7	0.4	0.7	0.6	0.8	0.8	0.8

GC X GC Fuel Analysis Summary Table

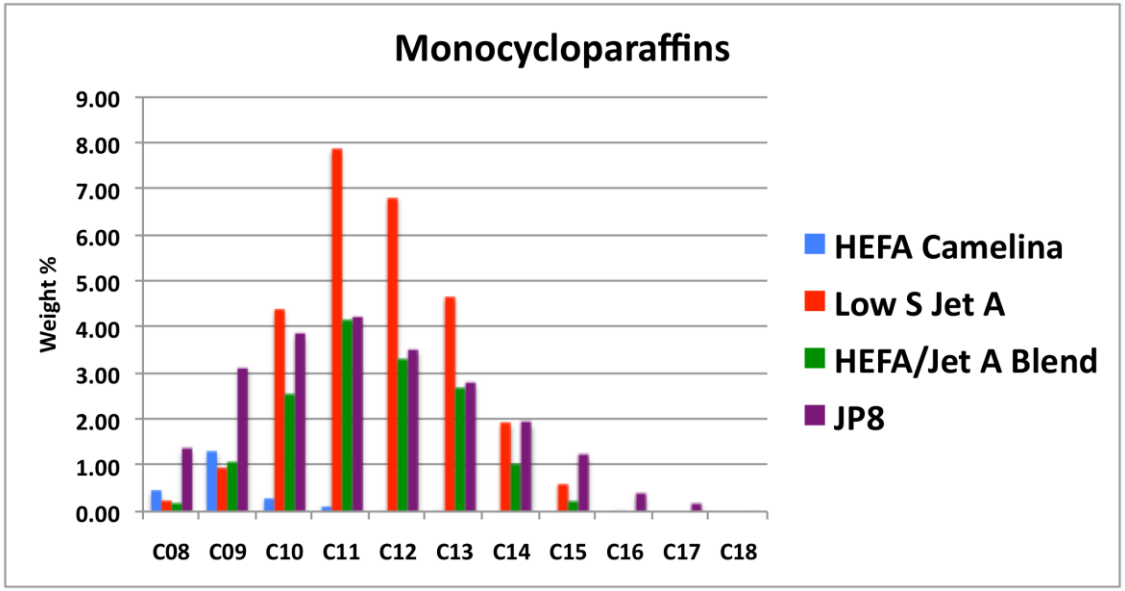
	JP-8	HEFA-Camelina	Low S Jet A	Med S Jet A	HEFA/Jet A Blend 1	HEFA/Jet A Blend 2
	Weight %	Weight %	Weight %	Weight %	Weight %	Weight %
Aromatics						
Total Alkylbenzenes	14.72	0.13	14.96	15.09	9.46	8.57
Total Alkylnaphthalenes	1.69	0.01	1.03	1.05	0.65	0.59
Total Cycloaromatics	8.06	0.03	6.26	6.29	3.94	3.52
Total Aromatics	24.47	0.18	22.26	22.44	14.05	12.67
Paraffins						
Total iso-Paraffins	26.52	86.72	24.70	24.23	50.63	54.60
Total n-Paraffins	18.48	10.62	18.93	18.94	15.69	15.27
Cycloparaffins						
Total Monocycloparaffins	22.84	2.30	27.23	27.52	15.30	13.54
Total Dicycloparaffins	7.64	0.18	6.80	6.80	4.28	3.87
Total Tricycloparaffins	0.05	<0.01	0.08	0.08	0.06	0.05
Total Cycloparaffins	30.53	2.48	34.11	34.40	19.64	17.46

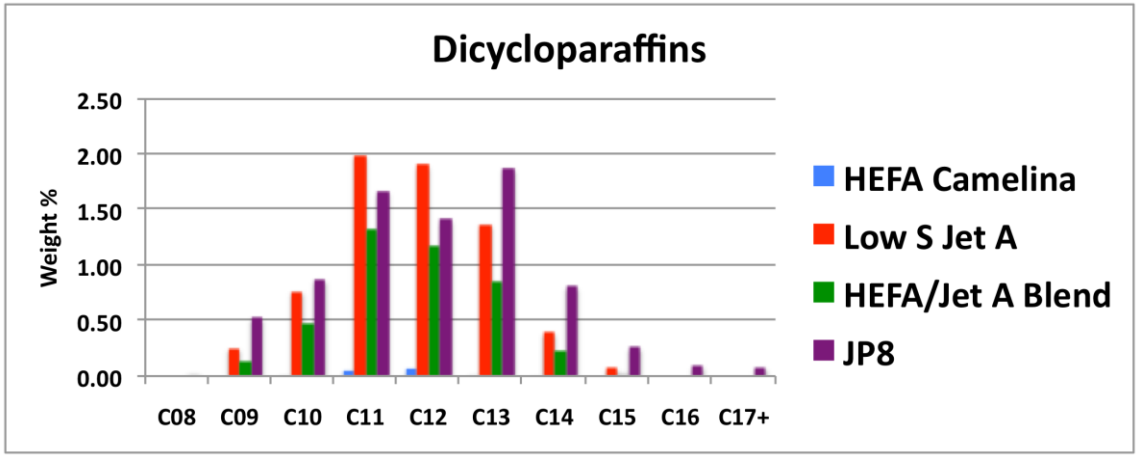
Paraffins


Iso-Paraffins
Weight %
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
C7&lower
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
HEFA - Camelina
Jet A
HEFA/Jet A Blend
JP8

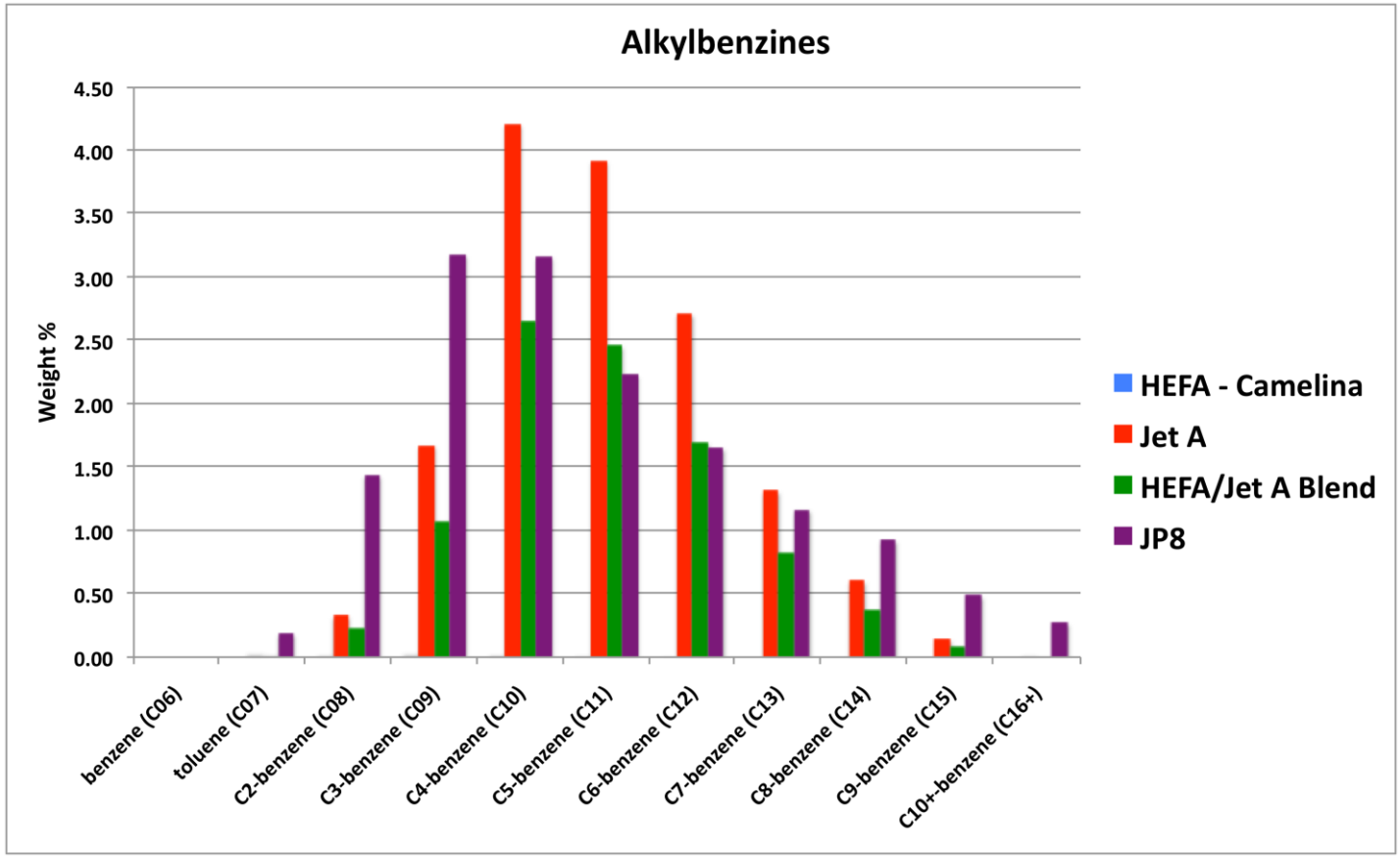

n-Paraffins
Weight %
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
n-C07 & lower
n-C08
n-C09
n-C10
n-C11
n-C12
n-C13
n-C14
n-C15
n-C16
n-C17
n-C18
HEFA - Camelina
Jet A

Cycloparaffins

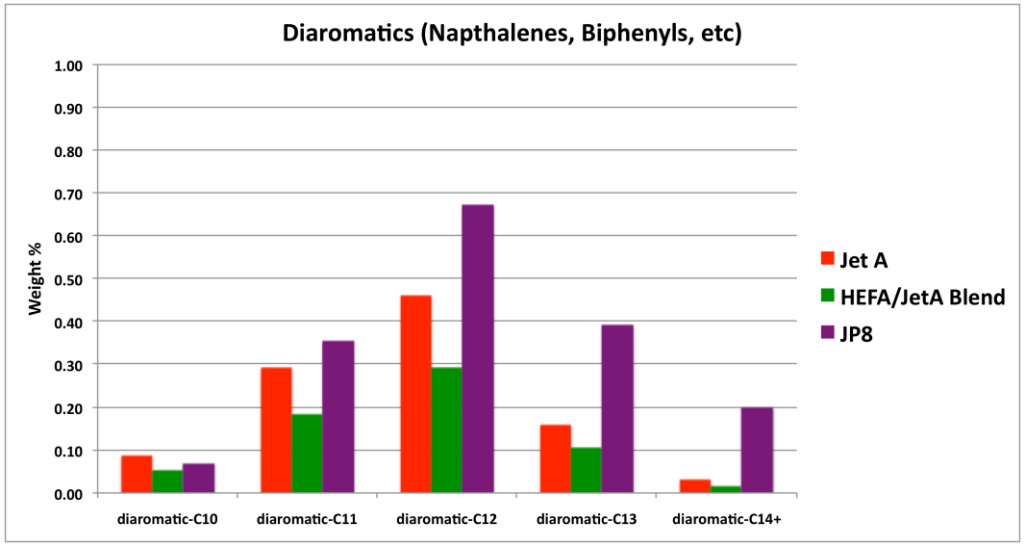


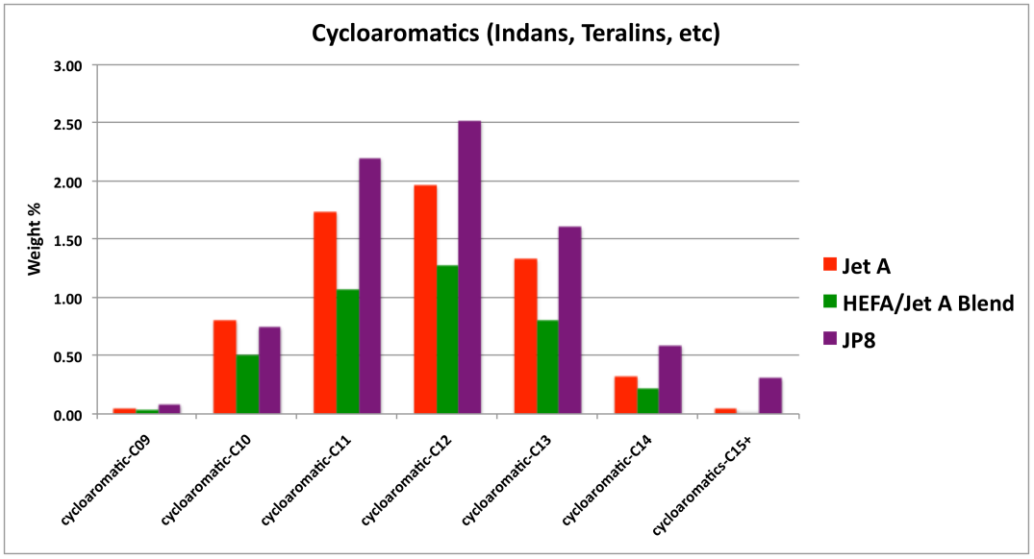


Aromatics

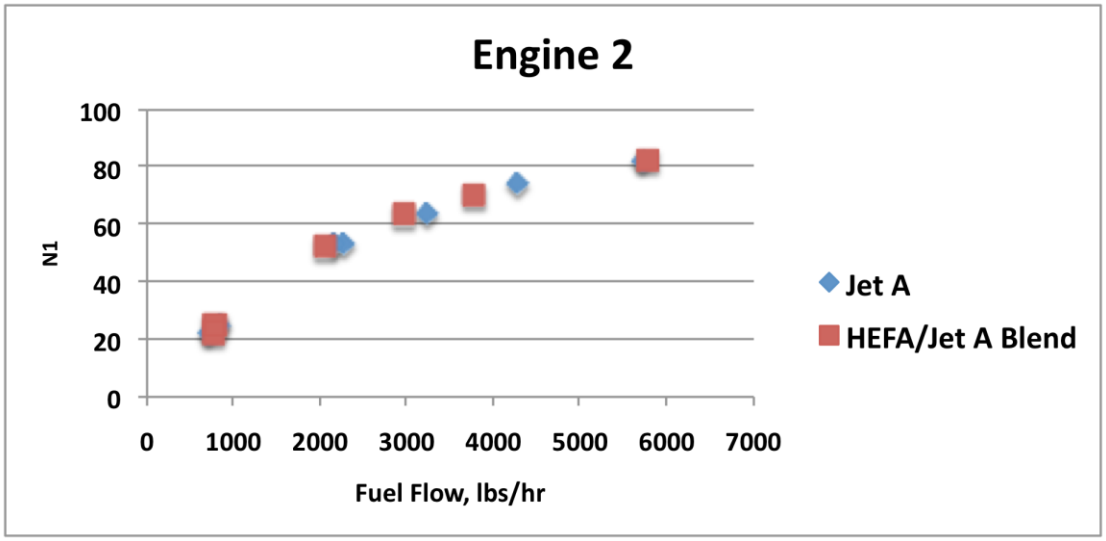

Alkylbenzines
Weight %
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
benzene (C06)
toluene (C07)
C2-benzene (C08)
C3-benzene (C09)
C4-benzene (C10)
C5-benzene (C11)
C6-benzene (C12)
C7-benzene (C13)
C8-benzene (C14)
C9-benzene (C15)
C10+-benzene (C16+)
HEFA - Camelina
Jet A
HEFA/Jet A Blend
JP8

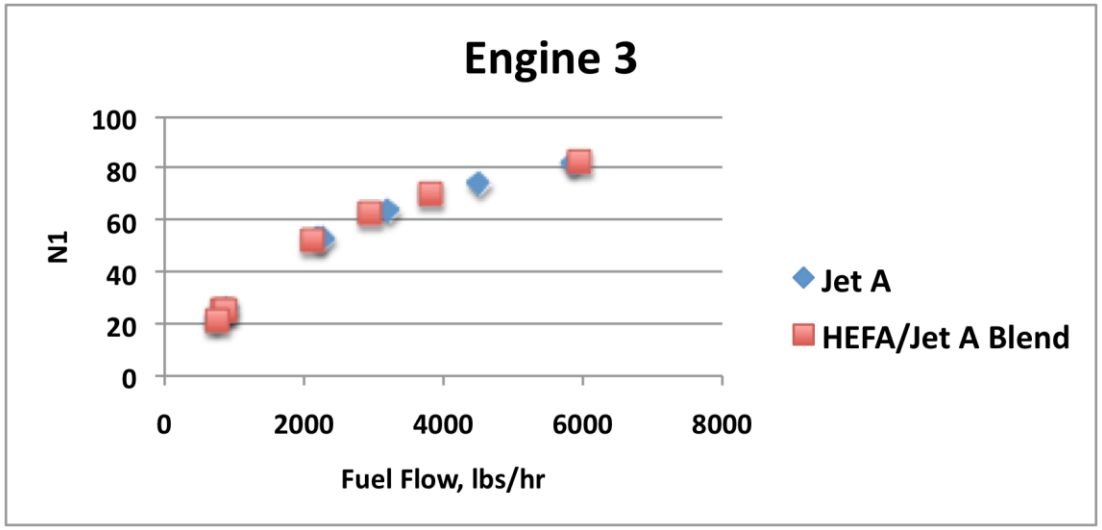
Aromatics


Diaromatics (Napthalenes, Biphenyls, etc)
Weight %
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
diaromatic-C10
diaromatic-C11
diaromatic-C12
diaromatic-C13
diaromatic-C14+
Jet A
HEFA/JetA Blend
JP8

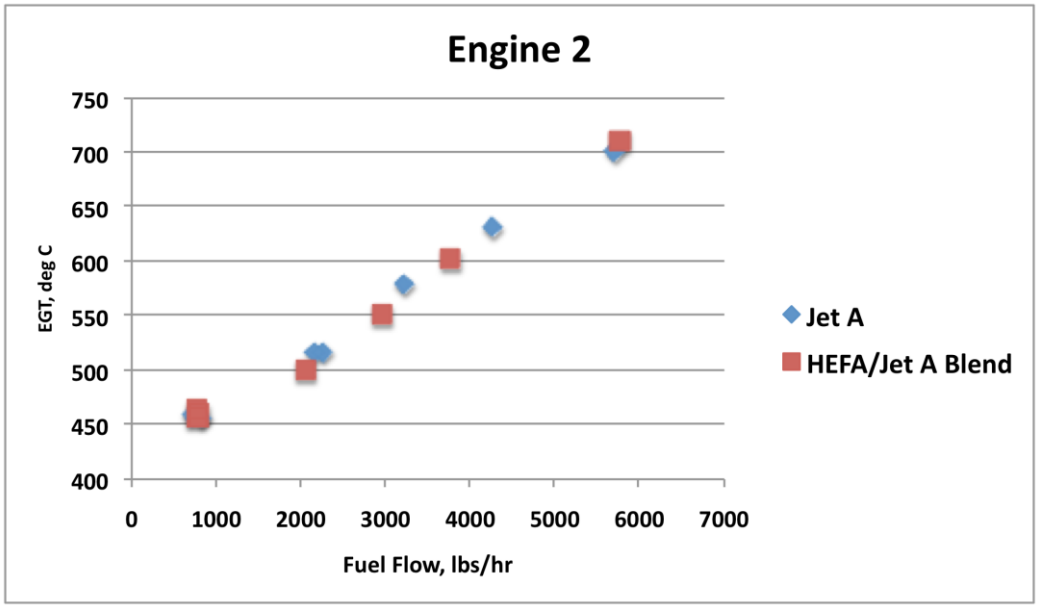

Cycloaromatics (Indans, Teralins, etc)
Weight %
3.00
2.50
2.00
1.50
1.00
0.50
0.00
cycloaromatic-C09
cycloaromatic-C10
cycloaromatic-C11
cycloaromatic-C12
cycloaromatic-C13
cycloaromatic-C14
cycloaromatics-C15+
Jet A
HEFA/Jet A Blend
JP8

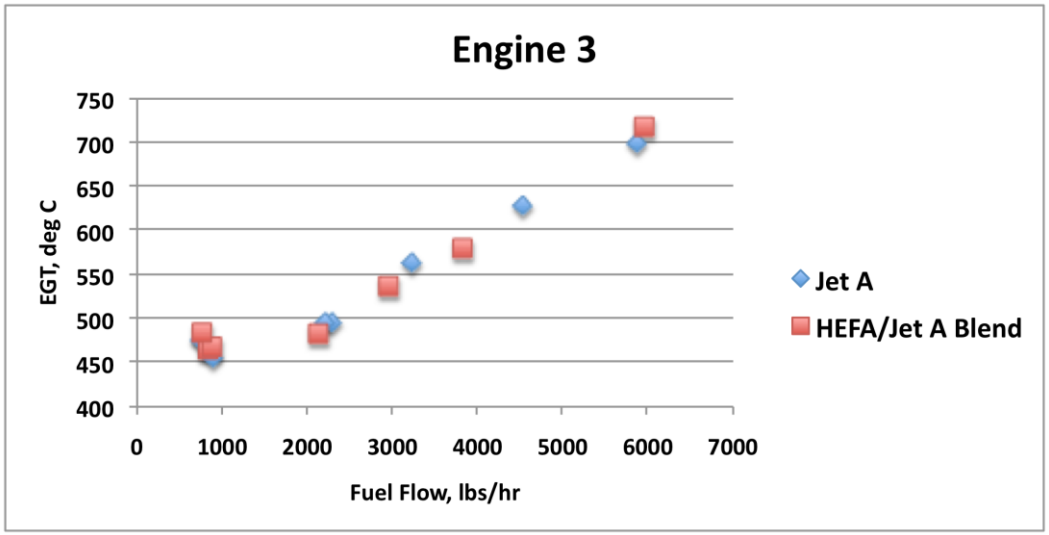
Engine Performance - Ground Test





Engine Performance – Ground Test





Acknowledgements

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